

BME4032: ROBOTICS AND MACHINE VISION

Effective Term

Semester B 2022/23

Part I Course Overview

Course Title

Robotics and Machine Vision

Subject Code

BME - Biomedical Engineering

Course Number

4032

Academic Unit

Biomedical Engineering (BME)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

MBE2029/MNE2029 Electrical and Electronic Principles I /
BME2029 Electrical and Electronic Principles or equivalent#

Precursors

Nil

Equivalent Courses

MBE4032 Robotics and Machine Vision

Exclusive Courses

Nil

Additional Information

Prerequisites which are not part of the Major Requirement are waived for students admitted with Advanced Standing.

Part II Course Details

Abstract

The aim of the course is to provide the students with the understanding of the basic principles underlying the design, analysis, and synthesis of robotic systems and machine vision technology in automation. This course will lay down the foundations of the engineering principles in such a way that the students can identify the appropriate concepts required in given engineering problems and apply them to formulate the suitable engineering solutions in automation and other applications.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 app.)		
		DEC-A1	DEC-A2	DEC-A3
1	Formulate and derive the kinematics for robot manipulators including direct and inverse kinematics.		x	
2	Analyze robot dynamics for control of serial links for robot manipulators.		x	
3	Demonstrate and compare the basic theories of machine vision and image processing.		x	
4	Apply robotics and visual sensing technologies to engineering applications.		x	x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Large class activities mainly include lectures.	1, 2, 3, 4	3 hrs/wk
2	Laboratory Work	The laboratory work will be conducted in small groups of 5-6 students for each lab.	1, 2, 3, 4	3 hrs/wk for 3 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignments	1, 2, 3	20	2 assignments
2	Laboratory Reports	3, 4	20	3 reports to be submitted

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

Assessment Rubrics (AR)

Assessment Task

Assignments

Criterion

- 1.1 Ability to Derive and Analyze the kinematics and control problems in the robotics framework.
- 1.2 Ability to Apply theories of machine vision.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Laboratory Reports

Criterion

- 2.1 Capacity for Self-Directed Learning to perform the experiments.
- 2.2 Ability to Explain and Interpret the results in the report.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Examination

Criterion

- 3.1 Ability to Analyze the problem from the engineering aspects.
- 3.2 Ability to Employ robotics principles to Solve the problems.
- 3.3 Ability to Demonstrate and Describe the work using robotics conventions.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- Coordinate transformation, scaling, rotational matrices, Euler angles.
- Forward kinematics, backward kinematics, graphical methods, Denavit–Hartenberg convention.
- Robot arm kinematics, Robot arm dynamics.
- Euler-Lagrange equation, PID control, joint-level control, sensing and control for robot manipulators.
- Machine vision systems, Image acquisition, Image pre-processing, Image filtering, Edge detection, Segmentation, Shape description and recognition, Camera calibration, Robot vision.

Reading List

Compulsory Readings

Title	
1	M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, Wiley, 2006.

Additional Readings

Title	
1	Siciliano, Bruno, and Oussama Khatib, eds., Springer handbook of robotics, Springer, 2016.
2	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer, 2011.
3	Rafael C. Gonzalez and Richard E., Woods: Digital Image Processing, Prentice Hall, 2nd Edition, 2001.